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Abstract

THERMAL PROBLEMS OF GAS-COOLED REACTORS FOR MAGNETOHYDRODYNAMIC POWER GENERATION

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Recent developments of magnetohydrodynamic (MHD) generators for large power production trend toward utilizing the possibility of inequilibrium non-thermal ionization for increasing the electron temperature over gas temperature thus enhancing the electrical conductivity of the flowing gaseous medium. Since the molecules of polyatomic gases possess internal degrees of freedom in addition to translational ones, they tend to absorb the excess energy of the electrons, thus only monoatomic gases in close circuit are suitable for electron temperature enhancement. A high temperature reactor, cooled by the monoatomic gas used as the flow medium for the MHD generator, is therefore the immediate choice.

Such a reactor presents stringent thermal design problems due to the requirement of intensive heat transfer and of moderate frictional power loss.

In this paper, these problems are discussed and methods of their solution given. It is shown that the ratio of frictional power loss to the heat rate and the ratio of the reactor core length to reactor core diameter are both related to the volumetric power density and to a linear dimension chosen as a characteristic length of the cooling matrix. A method is developed to take care of the large change of gas density during the passage through the reactor core. The difficulty of fulfilling the conditions imposed by the requirements of these quantities increases usually with the size of the reactor. The paper also shows that the requirements of the reactor and those of the MHD generator may dictate quite different choices of the most suitable gas medium.

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